

Claims

- 1 1. Method to denoise a stereo signal comprising a stereo sum signal and a stereo difference signal, **characterized by** a frequency selective stereo to mono blending based on the masking effect of the human auditory system.
- 5 2. Method according to claim 1, **chareacterized by** using noise included in the stereo audio signal as probe signal and an audio component of the audio signal as mask signal.
3. Method according to claim 1 or 2, **characterized by** determining the frequency selectivity by dividing the stereo difference signal into subbands.
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4. Method according to claim 3, **characterized by** determining a number of subbands according to the properties of the human auditory system.
- 15 5. Method according to claim 3 or 4, **characterized by** determining a width of a respective subband according to the properties of the human auditory system.
- 20 6. Method according to claim 3, 4 or 5, **characterized by** attenuating every subband of the stereo difference signal which noise component lies above a signal component of a subband of the audio signal corresponding to that of the stereo difference signal so that the noise component of the subband of the stereo difference signal lies below the respective absolute value of masking.
- 25 7. Method according to claim 6, **characterized in that** an attenuation factor of a respective subband is determined by dividing the signal component of the subband of the audio signal corresponding to the subband of the stereo difference signal by the noise component of the subband of the stereo difference signal.
- 30 8. Method according to claim 7, **characterized by** limiting the attenuation factor of a respective subband to values between 0 and 1.
- 35 9. Method according to claim 7 or 8, **characterized by** subtracting a respective influence factor (K_0, \dots, K_N) from the attenuation factor of a respec-

- 1 tive subband to reduce the influence of noise in the signal component to the
attenuation signal.
10. Method according to anyone of claims 6 to 9, **characterized by** deter-
5 mining the noise component of a subband of the stereo difference signal on ba-
sis of its noise power which is determined by filtering an in quadrature compo-
nent of the stereo difference signal into the respective subband and rms filter-
ing the corresponding subband.
- 10 11. Method according to claim 10, **characterized by** determining the noise
component of a subband of the stereo difference signal by weighting its noise
power according to a respective corresponding absolute threshold of masking
(M_0, \dots, M_N), the fieldstrength of the received fm signal, a volume of output
15 sound, a background noise level, the signal amplitude power of the audio sig-
nal, a speed of a vehicle within which the stereo signal is reproduced, and/or
the ratio of the signal power to the noise power of the difference signal of the
corresponding subband.
12. Method according to anyone of claims 6 to 11, **characterized by** deter-
20 mining the signal component corresponding to a subband of the stereo differ-
ence signal according to the fieldstrength of the received fm signal, a volume of
output sound, a background noise level, the signal amplitude power of the
audio signal, a speed of a vehicle within which the stereo signal is repro-
duced, and/or the ratio of the signal power to the noise power of the difference
25 signal of the corresponding subband.
13. Method according to claim 12, **characterized by** weighting the squared
subband signal of the in phase component of the stereo difference signal with
a weighting factor (W_0, \dots, W_N) according to the fieldstrength of the received fm
30 signal, a volume of output sound, a background noise level, the signal ampli-
tude power of the audio signal, a speed of a vehicle within which the stereo
signal is reproduced, and/or the ratio of the signal power to the noise power of
the difference signal of the corresponding subband.
- 35 14. Computer program product, comprising computer program means
adapted to perform the method steps as defined in anyone of claims 1 to 13
when it is executed on a computer or digital signal processor.

1 15. Stereo signal noise reducer, comprising a first filter bank (1) to split the
stereo difference signal (l-r) into a plurality of subbands, respective first multi-
pliers ($2_0, \dots, 2_N$) to weight each of the subbands of the stereo difference signal
with a respective corresponding control signal (C_0, \dots, C_N), and a first adder (3)
5 to sum all weighted subbands of the stereo difference signal (l-r) to build a fre-
quency selective weighted stereo difference signal (diff), **characterized in that**
a number and width of the subbands obtained via the first filter bank (1) are
chosen according to the properties of the human auditory system, **and by a**
weighting factor determination unit which determines a respective control sig-
10 nal (C_0, \dots, C_N) frequency selective based on the masking effect of the human
auditory system.

16. Noise reducer according to claim 15, **characterized in that** said weight-
ing factor determination unit comprises
15 - a respective division unit (4) to determine a ratio of a signal component of
each of the subbands of the audio signal corresponding to the subbands of the
stereo difference signal to a noise component of each of the subbands of the
stereo difference signal (l-r).

20 17. Noise reducer according to claim 16, **characterized in that** said weight-
ing factor determination unit comprises
- a respective second adder ($5_0, \dots, 5_N$) to determine the control signal ($C_0, \dots,$
 C_N) by subtracting a respective influence factor (K_0, \dots, K_N) from the output
signal of the division unit (4) to reduce the influence of noise in the signal
25 component to said control signal (C_0, \dots, C_N).

18. Noise reducer according to claim 15, 16 or 17, **characterized in that**
said weighting factor determination unit comprises
- a mixer (6) and a first lowpass filter (7) to determine the noise component of
30 the stereo difference signal (l-r) by deriving its in quadrature component, and
- a second filter bank (8) having the same characteristics as the first filter
bank (1) to determine the noise component of each of the subbands of the ste-
reo difference signal (l-r).

35 19. Noise reducer according to claim 18, **characterized in that** said weight-
ing factor determination unit comprises
- a respective first rms determinator (9) receiving a respective output signal of

- 1 the second filter bank (8) to determine the respective noise power corresponding to the respective noise component of a subband of the stereo difference signal (l-r).
- 5 20. Noise reducer according to claim 19, **characterized in that** said weighting factor determination unit comprises
- a respective second multiplier ($10_0, \dots, 10_N$) to determine the noise component of a subband of the stereo difference signal (l-r) by weighting the respective noise power according to a respective corresponding absolute threshold of
- 10 masking (M_0, \dots, M_N), the fieldstrength of the received fm signal, a volume of output sound, a background noise level, the signal amplitude power of the audio signal, a speed of a vehicle within which the stereo signal is reproduced, and/or the ratio of the signal power to the noise power of the difference signal of the corresponding subband.
- 15 21. Noise reducer according to anyone of claims 16 to 20, **characterized in that** said weighting factor determination unit comprises
- a third filter bank (11) having basically the same characteristics as the first filter bank (1) to determine the signal component of each of subbands of the
- 20 stereo sum signal (l+r) corresponding to the subbands of the stereo difference signal (l-r).
22. Noise reducer according to claim 18, **characterized in that** said weighting factor determination unit comprises
- a respective second rms determinator ($12_0, \dots, 12_N$) receiving respective corresponding output signals of the first filter bank (1), the third filter bank (11) or the first and third filter banks (1, 11) to determine the respective signal power corresponding to the signal component of each of the subbands of the
- 25 stereo signal.
- 30 23. Noise reducer according to claim 22, **characterized in that** said weighting factor determination unit comprises
- a respective third multiplier ($13_0, \dots, 13_N$) to determine the signal component of each of the subbands of the stereo signal by weighting the respective output
- 35 signal of the first filterbank (1) with a weighting factor (W_0, \dots, W_N) according to the fieldstrength of the received fm signal, a volume of output sound, a background noise level, the signal amplitude power of the audio signal, a

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